

**ADMINISTRATIVE BULLETIN**

**NO. AB-047**

**DATE:**

**SUBJECT:** Smoke Control Systems

**TITLE:** **Specific Submittal Criteria for Reports, Special Inspections and Final Acceptance Testing of Smoke Control Systems.**

**PURPOSE:** This Administrative Bulletin outlines the minimum requirements for smoke control systems in the City and County of San Francisco; it covers (1) design criteria, (2) required submittals and documentation. This Administrative Bulletin applies to both new and existing smoke control systems.

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**1. REFERENCED PUBLICATIONS**

These documents are considered part of this Administrative Bulletin.

1. 2010 California Building Code (CBC) / San Francisco Building Code (SFBC)
2. 2010 California Fire Code (CFC) / San Francisco Fire Code (SFFC)
3. 2010 California Mechanical Code (CMC) / San Francisco Mechanical Code (SFMC).
4. 2010 California Electrical Code (CEC) / San Francisco Electrical Code (SFEC).
5. 2009 NFPA 92A, Recommended Practices for Smoke-Control Systems
6. 2005 NFPA 92B, Smoke Management Systems in Malls, Atria and Large Spaces
7. *Guide to the 2006 IBC Smoke-control Provisions*, Dr. John H. Klote and Douglas H. Evans, P.E., 2006 International Building Code.
8. ASHRAE Guideline 5-1994, *Commissioning Smoke Management Systems*.
9. SMACNA, HVAC Air Duct Leakage Test Manual, First Edition, 1985.

**2. GENERAL**

**2.1. Alternate Methods of Smoke Control**

- 2.1.1. Equivalent/Alternate methods should be pre-approved by DBI/SFFD. See DBI Administrative Bulletin AB-005 for information regarding local equivalencies and DBI Administrative Bulletin

AB-028 for information regarding pre-application or pre-addendum meetings. Examples of alternate methods are Natural Ventilation (not applicable to 909.20.3; Smoke proof enclosures), Garage CO Exhaust. Additional justification and analyses are required to show the method provides an equivalent level of life-safety to prescribed methods; typically consisting of providing documentation and supporting calculations.

### **3. SMOKE CONTROL SYSTEM DESIGNERS QUALIFICATIONS**

- 3.1. The building owner shall engage an architect, mechanical engineer and electrical engineer as architect and engineers-of-record, to prepare Smoke Control System design documents [SFBC 106A.3.4]. All design professionals shall be licensed in the State of California [CBC 202]. The architect and engineers-of-record shall be responsible for reviewing and coordinating all submittal documents, including reports and deferred submittals, for compatibility with the building design [SFBC 106A.3.4].

If a smoke control consultant is engaged, this person shall be experienced in smoke control systems and shall be a fire protection engineer or mechanical engineer licensed in the State of California.

- 3.2. When peer review is required by DBI/SFFD, the reviewer shall be approved by DBI/SFFD, and engaged by the owner or owner's agent.

### **4. RESPONSIBILITIES**

#### **4.1. Project Owner**

- 4.1.1. Designate Responsible Design Professionals and Smoke Control Report Author
- 4.1.2. Authorize Peer Review (where applicable)
- 4.1.3. Contract development and implementation of Special Inspection Program
- 4.1.4. Contract Air Balancer and Special Inspector(s)
- 4.1.5. Coordinate Document Submittals:
- 4.1.5.1. Alternate materials and methods requests
- 4.1.5.2. Preliminary Smoke Control Report
- 4.1.5.3. Final Smoke Control Report (including amendments)
- 4.1.5.4. Special Inspection Proposal for Smoke Control
- 4.1.5.5. Final Special Inspection Report
- 4.1.6. Coordinate Plan Submittals
- 4.1.6.1. Site Plan
- 4.1.6.2. Architectural Plan, including smoke barrier plan
- 4.1.6.3. MEP Plans

4.1.6.4. Fire Alarm Plans including Control Diagrams and Smoke Control Panel Layout

4.1.6.5. Sprinkler Plans

## **4.2. Design Professionals**

4.2.1. Architect of Record

4.2.1.1. Architectural Design and Smoke Barrier Plans in accordance with the smoke control report.

4.2.1.2. Must review architectural submittals by others to assure that smoke control system is coordinated into design.

4.2.1.3. Inspect construction, and when satisfied that the design intent has been achieved, the architect shall seal, sign, and date the special inspection report in designated area.

4.2.2. Mechanical Engineer of Record

4.2.2.1. Mechanical Design in accordance with smoke control report and code requirements.

4.2.2.2. Must review mechanical, fire alarm, sprinkler submittals by others to assure that smoke control system is coordinated into design.

4.2.2.3. Inspect construction, and when satisfied that the design intent has been achieved, the mechanical engineer of record shall seal, sign, and date the special inspection report in designated area.

4.2.3. Electrical Engineer of Record

4.2.3.1. Electrical Design in accordance with smoke control report and code requirements.

4.2.3.2. Must review electrical and fire alarm submittals by others to assure that smoke control system coordinated into design.

4.2.3.3. Inspect construction, and when satisfied that the design intent has been achieved, the electrical engineer of record shall seal, sign, and date the special inspection report in designated area.

## **4.3. Smoke Control Report Author**

4.3.1. Prepare Preliminary Smoke Control Report in accordance with architectural design.

4.3.2. Prepare Final Smoke Control Report (including amendments.)

4.3.3. Establish smoke control system design, and pass/fail criteria; including necessary weather conditions acceptable during commissioning testing without further review.

4.3.4. Communicate with Peer Reviewer (where applicable), Fire Department, Department of Building Inspection during review and inspection phases.

## **4.4. Contractor**

- 4.4.1. Provide inspection/testing access prior to concealment of ductwork, wiring, piping, etc.
- 4.4.2. Marking and identification of all smoke control components.
- 4.4.3. Pre-testing of all equipment and systems prior to special inspection.
- 4.4.4. Coordinate special inspection and AHJ testing.

#### **4.5. Department of Building Inspection**

- 4.5.1. Review Plans and Submittals.
- 4.5.2. Mandate Peer Review (when necessary.)
- 4.5.3. Perform field inspections.
- 4.5.4. Review special inspection report.
- 4.5.5. Provide Certificate of Final Completion when work is completed.
- 4.5.6. Custodian of Records (microfilm.)

#### **4.6. Fire Department**

- 4.6.1. Review Plans and Submittals.
- 4.6.2. Mandate peer review (when necessary.)
- 4.6.3. Approval of Preliminary Smoke Control Concept and Final Smoke Control Report and Special Inspection Program.
- 4.6.4. Authorize fabrication of smoke control panel after approval.
- 4.6.5. Perform field inspections/witness testing and verify compliance with approved plans and documents.
- 4.6.6. Review of final special inspection report by Fire Plan Check.
- 4.6.7. Communication of deficiencies and required corrections with Plan Check, field inspectors, special inspectors, and design professionals.
- 4.6.8. Provide approval documentation when work is complete.

#### **4.7. Special Inspector or Special Inspection Agencies**

- 4.7.1. Develop special inspection procedure/program (written proposal.)
- 4.7.2. Prepare special inspection report.
- 4.7.3. Witness test and document all devices affecting smoke control system.
- 4.7.4. Inspect and document all architectural features affecting smoke control design.

- 4.7.5. Where deficiencies are noted during a site visit prepare and post deficiency reports with the permit posted at the job site and notify the contractor and responsible design professionals of corrections required [CBC 1704.1.2.]

#### **4.8. Air Balancer**

- 4.8.1. Perform all required testing with properly calibrated instruments.
- 4.8.2. Document all testing and inspection results and provide to Special Inspector(s).

### **5. SUBMITTALS FOR SMOKE CONTROL SYSTEMS**

#### **5.1. General**

- 5.1.1. Submit two sets of the following: all reports in booklet format (e.g. spiral bound), 8 ½" x 11" sheets; drawings, minimum 11"x17" sheets. One set of each will be returned when approved. Reports shall be accompanied by two sets of CD-Rs with a copy of the report in PDF format including all appendices, diagrams, and all supporting calculation files (with all supporting design scenarios and data files) "burned" onto the CDs. Each CD shall be in a slim plastic "jewel case" with a clear cover. The permit application number, report title, project name and address, CD-R files, report date, and revision number shall be clearly labeled on the CD-R.
- 5.1.2. Construction documents shall include sufficient information and detail to adequately describe the design and properly facilitate installation.
- 5.1.3. Three types of reports are required: (1) the Smoke Control Report, (2) Special Inspection Program, and (3) Special Inspection and Testing Final Report. Approval of the Smoke Control Report and Special Inspection Program are required before the Mechanical Permit is issued. Provide the (3) Final Testing Report [CBC 909.18.8.3] and Identification and Documentation [909.18.9] to DBI/SFFD at project completion.
- 5.1.4. A complete Special Inspection Program with sample reports shall be submitted with the mechanical plans to DBI/SFFD for review and approval **prior** to issuance of the mechanical permit. Refer to Special Inspection Program requirements section.

#### **5.2. Smoke Control Report**

- 5.2.1. A written report, titled Smoke Control Report, shall be authored by the smoke control consultant or the mechanical engineer-of-record and submitted to DBI/SFFD for review and approval. The Smoke Control Report is typically a multi-phased approval process and submitted as follows:
- 5.2.1.1. For site permit projects submit a preliminary Smoke Control Report with the site permit drawings. The preliminary Smoke Control Report is generally conceptual in nature, but still includes all aspects required in the final report, including AB-047 Signature Page-attachment 1, less the specific calculations, supporting data, and diagrams. The acceptance of the preliminary Smoke Control Report does not constitute final approval by SFFD or DBI. Submit the Smoke Control Report as part of the review and approval process of the Architectural, Mechanical, and Electrical addendum drawings.
- 5.2.1.2. For all projects without a site permit, submit the complete Smoke Control Report with the Architectural drawings (for reference). Submit the Smoke Control Report and Special

Inspection Program with the Mechanical, and Electrical drawings, as part of the drawings' review and approval process.

- 5.2.1.3. If the Smoke Control Report is revised after approval by DBI/SFFD, the revised report shall be resubmitted with all items required and provided in the original submittal and revised plans showing applicable changes.
- 5.2.2. The Smoke Control Report shall include the following information:
- 5.2.2.1. Cover Page: Provide a cover page showing the facility name, address, revision number, permit application and revision numbers, date of submittal and preparer.
- 5.2.2.2. Signature Page: Provide a completed signature page with final report; AB-047 attachment 1.
- 5.2.2.3. Code References. Provide reference to and include copies in appendices of all approved alternate means and methods, and pre-application agreements relating to smoke control. List all applicable codes standards including editions, approved equivalencies, and pre-application agreements for the project.
- 5.2.2.4. Building Description. Provide a general narrative overview of the building and its uses. Include the building height, number of stories, basement levels, gross floor area, types of occupancies and type(s) of construction, approved variances and equivalencies. Identify the architectural features that affect smoke control design and life-safety: size of atriums, location of fire/smoke barriers, fire-safeing, engineering judgments, make-up air openings, operable windows, vents, floor and wall openings, door closers, ceiling heights, pressurized and non-pressurized stair enclosures, open stairs, shafts used as ducts, duct construction and material, exiting, horizontal exits, heights and types of surrounding structures/buildings, Elevators for Firefighters use.
- 5.2.2.5. Fire suppression systems. Provide a concise narrative overview of the fire suppression system(s). Identify the types of systems and areas served (zoning), major equipment, design criteria and basic operation. Identify the type, location and quantity of flammable or combustible fuel, and hazardous/toxic materials, if any.
- 5.2.2.6. HVAC and ventilation systems. Provide a concise narrative overview of the HVAC systems whether or not used for smoke control. Identify the types of systems and areas served (zoning), major equipment, fire and smoke dampers type and class including link temperatures, design objectives and basic operation. Identify where fire dampers have actuating devices with increased operating temperatures (not more than 350 °F) due to smoke control [CBC 716.3.3.1] and specify the actuating temperatures for each type of fire damper. Identify where fire/smoke dampers are not provided due to smoke control [CBC 716.2.1; 716.5.3, #1.3, #4]. Identify where fire/smoke dampers are not provided at shafts due to 22-inch sub-ducts and continuously operating exhaust fans connected to the standby power system [CBC 716.5.3, #1.1, #2.2, #2.3].
- 5.2.2.7. Power supply systems. Provide a concise narrative overview of the primary and standby power sources for the smoke control systems. Include the locations of the standby power source, transfer switches, normal power transformers and switchgear, and describe the independent routing of the normal and standby power distribution systems [CBC 909.11]. Identify the type, location and quantity of flammable or combustible fuel, if any. Address the need for uninterruptible power supplies and power surge protectors [CBC 909.11.1]. Provide a table to indicate all equipment required to be connected to emergency power. Specify the

required duration the Stand-by/Secondary Power supply is required to operate the Smoke Management System [909.4.6]. Note emergency power is usually required for scavenger fans.

- 5.2.2.8. Fire alarm, detection and control systems. Provide a concise narrative overview of the fire alarm, detection and control systems as they relate to the smoke control system. Include the building management system (BMS) where used for or interconnected to the smoke control system. BMS systems shall be listed for smoke control use. Identify the smoke control components that must be monitored for proper operation (supervised end-to-end) and the method of supervision [CBC 909.12]. Address the listing of fire detection and control systems (UL category UUKL) including the building management system where used for smoke control [CBC 909.12].
- 5.2.2.8.1. Damper supervision and control at the Firefighters Control Panel is required for all active-passive zone boundaries, e.g. corridor to residential units, group control and interlocking on fans with dampers is allowed. The minimum acceptable supervision and control required will indicate proper damper operation and fault condition for smoke control operation i.e. open and closed. These dampers shall be included in the UUKL Self-Test and fail-safe in the closed position [CBC 909.]
- 5.2.2.8.2. Fan supervision and control at the Firefighters Control Panel is required for all fans used in the smoke control system [CBC 909.16.] Each fan and damper shall have a separate annunciator lights and controls, unless otherwise approved. Power (amperage and voltage) shall be supervised at the downstream side of the electrical disconnects [CBC 909.12] and a positive means of verifying airflow shall be provided (pressure switch / airflow sensor) [NFPA 92A 6.4.3.7.7] at each fan and indicated on the Firefighters Control Panel as a fault condition if failure occurs. Supervision and control of additional fans shall be required in cases where an alternate/equivalent method is approved, e.g. where garage CO exhaust is utilized for smoke control, and use of supply fans are necessary for adequate smoke exhausting.
- 5.2.2.9. Firefighters Control Panel. Include a narrative description of the Firefighters Control panel. Refer to the Fire Alarm Plan submittal section for additional information.
- 5.2.2.10. Smoke Control/Management Systems. Provide a concise conceptual narrative overview of the smoke control/management systems: concepts, approaches, and design objectives, types of systems, zoning, major equipment, analysis methods, and basic operation and activation sequences.
- 5.2.2.11. As applicable provide a detailed description of each smoke control zone including: occupancy; fire suppression and fire alarm systems, including specific design criteria required by the smoke control system; construction type, ratings and leakage values; door and window types, ratings, leakage values, and closing methods; operable and fixed exterior openings; expected fire size/loads, combustible materials [CFC]; means of egress; method(s) of smoke control; analyses methods, with referenced equations for hand calculations, name and version of software; design scenarios addressed, including specific weather data used for each scenario; summary of results including but not limited to tenability, timed egress, i.e. ASET vs. RESET; sprinkler type and activation times; activation methods.



- 5.2.2.12. Provide small-scale drawings, 11" x 17" minimum, showing the location of all smoke zones, including passive smoke zones; include the drawings as PDF files on the required CD-R.
- 5.2.2.13. Provide rational analyses of the design; address the stack effect, temperature effect of the fire, wind, HVAC interactions, climate and minimum duration of operation [CBC 909.4.4, 909.4.5, 909.10].
- 5.2.3. For smoke control systems using the passive method, identify the total leakage area for typical smoke barriers [CBC 909.5.1].
- 5.2.4. Address the probable temperatures to which fans, dampers and ducts may be exposed in a fire [CBC 909.10].
- 5.2.5. Identify smoke zone openings which must be open or closed for proper operation, such as doors, windows, dampers and louvers; identify smoke zone openings that are supervised in the open and/or closed positions.
- 5.2.6. Address the piston effect of elevators. Additionally, for single car elevator shaft provide calculations to show the smoke control system is not overcome by the piston effect.
- 5.2.7. For smoke control systems, identify the system components tested weekly by the automatic self-test feature [CBC 909.12; UL 864].
- 5.2.8. Design Fundamentals; Where applicable the following Guidelines shall apply
- 5.2.8.1. Design Fire
- 5.2.8.1.1. A design fire engineering analysis shall be provided in the smoke control report [909.9]. Address the fuel characteristics (e.g. toxicity, particulate yield, and growth rate), fuel spacing and configurations (radiant heat), heat-release assumptions (HRR), and sprinkler effectiveness assumptions. Justify all assumptions and performance-based approaches. Identify the computer program(s) and version(s) used, if any. Include calculations and an input and output summary for each computer analysis design case.
- 5.2.8.1.2. Specify the maximum ceiling jet temperatures and time lag expected before sprinkler activation. Provide supporting calculations.
- 5.2.8.2. Pressurization Method
- 5.2.8.2.1. Stairway pressurization systems: Comply with CBC 909.20 to 909.20.4 and NFPA 92A 5.34. Use of vestibule transfer grills is not acceptable except for pressurization of large stairway transfer passageways.
- 5.2.8.2.2. Pressurization calculations may be based on maximum leakage values provided in the CBC [CBC 909.5.] However, architectural specifications for construction leakage may be used if documented in report.
- 5.2.8.2.3. A minimum Pressure differential of 0.05-water gauge is required across all smoke barriers in fully sprinklered buildings. Un-sprinklered buildings shall comply with CBC 909.6.1 for pressure differentials. [CBC 909.6, 909.6.1]
- 5.2.8.2.4. Computer calculations shall be provided for all buildings utilizing a multizone model program that is valid for the application, e.g. CONTAM. State all variables used/required in

the calculations and additional modifiers are available and used in the calculations, e.g. Wind Tunnel data, provide information in the report. Hand calculations may be provided and/or required to verify computer calculations.

- 5.2.8.2.5. Base calculations input data on 1 percent wind speeds and dry bulb temperatures of 99.6 and 0.4 percent (NFPA 92A, A.4.6.2.) Include prevailing winds, summer and winter, and all other wind directions considered critical to demonstrate wind effects. Current wind data shall be obtained from a nationally recognized authority, e.g. ASHRAE, and included in the report. Use of site specific wind data is recommended.
- 5.2.8.2.6. All exterior openings and non-smoke management fans in smoke control zones and sub-zones that are operable in smoke control mode shall be included in the analysis in their normal position, e.g. windows, doors, scavenger fans, z-ducts and vents (NFPA 92A, 4.6.1, and 7.1.1.2.)
- 5.2.8.2.7. For smoke control systems using the pressurization method, identify the minimum and maximum pressure differences across smoke zone boundaries (smoke barriers) separating smoke zones [CBC 909.6.1]. Include calculations for each smoke zone where appropriate. Analyses shall include all openings fixed in open position, and within reason openings expected to be opened, e.g. Z-ducts, operable windows and/or doors [NFPA 92A 7.1.1.2.]
- 5.2.8.3. Exhaust Method: Typically used in large volume areas, e.g. atriums [CBC 909.8.]
- 5.2.8.3.1. Where space is a simple geometry (no obstructions, simple air supply/makeup air and exhaust, symmetrical square construction) exhaust of smoke may be done using NFPA 92B algebraic calculations.
- 5.2.8.3.2. In spaces with complicated geometries and/or tenability is used as design criteria, CFD analysis may be required. A complicated geometry is where airflow is obstructed, multiple air supplies, or construction is asymmetrical.
- 5.2.8.3.3. All exterior openings and non-smoke management fans in smoke control zones and sub-zones that are operable in smoke control mode shall be included in the analysis, e.g. windows, doors, scavenger fans and vents.
- 5.2.8.4. Natural Ventilation
- 5.2.8.4.1. Designs that utilize natural ventilation (not applicable to 909.20.3; Smoke proof enclosures) in whole or part of the smoke management system will require CFD or physical (scale) model analysis.
- 5.2.8.4.2. The affect of outdoor wind, temperature, design fire size, and the surrounding structures are especially important in the design of natural ventilation smoke control. Multiple design scenarios that reflect a complete range of operating conditions are required to demonstrate the validity of the smoke control systems' function.
- 5.2.8.4.3. Wind speeds shall range from zero to the 1 percent annual extreme. Include prevailing winds, summer and winter, and a minimum of 4 other wind directions considered critical to demonstrate wind affect at the required wind speeds. Current wind data shall be obtained from a nationally recognized authority, e.g. ASHRAE, and included in the report.

- 5.2.8.4.4. Ambient temperature used in calculations shall range from low to high annual extremes, dry bulb temperatures of 99.6 and 0.4 percent, as reported by the most current data obtained from a nationally recognized authority, e.g. ASHRAE.
- 5.2.8.4.5. For verification of commissioning and testing data provide design calculations for the temperature(s) and wind condition(s) experienced during the testing.
- 5.2.8.4.6. All openings in smoke control zones that are operable shall be included in the analysis, e.g. windows, doors, and vents. Separate design scenarios for each zone with open and openings closed shall be included.
- 5.2.8.5. Airflow Method: Typically used in tunnels or spaces connected to large volume spaces to manage the flow of smoke from fires.
- 5.2.8.5.1. Simple geometrical spaces (no obstructions, simple air supply and exhaust, symmetrical smooth construction) the critical air velocity calculation required to prevent the backflow of smoke may be per NFPA 92B, section 5.5, Opposed Airflow and CBC 2010, section 909.7.
- 5.2.8.5.2. In spaces with complicated geometry (rough, asymmetric construction) and/or where/when tenability is used as design criteria, CFD analysis is required. A complicated geometry is where airflow is obstructed, multiple air supplies, or construction is asymmetrical.
- 5.2.8.5.3. All openings in smoke control zones that are operable shall be included in the analysis, e.g. windows, doors, and vents. Separate design scenarios for each zone with open and openings closed shall be included.
- 5.2.8.6. Tenability: Tenability criteria shall be established based on approved documented studies. Items to be included, but not limited to, determining tenability criteria are the following: temperature and humidity, visibility (KS=3, light reflecting), toxicity assessment of combustion products and FED.
- 5.2.8.7. Egress Analysis: Timed egress analyses shall be based on CBC 909.4.6 (where duration of system is less than 20-minutes) based on documented methods as provided in the listed references. Calculation of Available Safe Egress Time (ASET) and Required Safe Egress Time (RSET) with a minimum safety factor of (1.5). ASET and RSET shall be calculated in phases/time segments: ignition-detection, detection-alarm, alarm-perception, perception-interpretation, interpretation-action, action-movement, and tenability limit only for ASET. Occupancy loads shall be determined by the CBC or actual occupant load, whichever is greater. Consideration shall be made for handicapped and disabled occupants by reduction of travel speeds and flow rates. Lastly, duration of the smoke management system operation shall be the code required minimum or the maximum RSET, whichever is greater.

### 5.3. Architectural Drawings

- 5.3.1. Include a compliance statement stamped and wet signed by the architect-of-record which states:

“I have reviewed the Smoke Control Report and confirm the smoke management/control system shown in these drawings complies with the Smoke Control Report by *REPORT AUTHOR and DATE OF REPORT.*”

- 5.3.2. As part of the architectural drawings provide smoke barrier drawings showing the location of all smoke zones: delineate each zone as passive or active and provide a zone designation for each active zone. Additionally, show occupancies of each smoke zone and all openings required e.g. doors required to open for make-up air. The zones and designations used in the architectural drawings shall correspond to zones and designations used in the smoke control report.
- 5.3.3. Provide sufficient detail in the drawings to support engineering calculations, e.g. leakage values for walls, ceilings, and doors; locations and heights of surrounding buildings; sizes and locations of make-up air openings; and smoke-barrier wall construction details.

#### **5.4. Mechanical Permit Drawings**

- 5.4.1. In addition to the information that is typically provided in mechanical drawings, provide the following information in the drawings:
- 5.4.1.1. Include a compliance statement stamped and wet signed by the mechanical engineer-of-record which states:
- “I have reviewed the Smoke Control Report and confirm the smoke management/control system shown in these drawings complies with the Smoke Control Report by *REPORT AUTHOR and DATE OF REPORT.*”
- 5.4.1.2. Submit approved architectural plans that show the location of all smoke zones, including passive smoke zones.
- 5.4.1.3. Provide a schematic riser diagram of the smoke control/management systems.
- 5.4.1.4. Provide a narrative summary and sequence of operations of the smoke control/management system operation.
- 5.4.1.5. Identify the major mechanical components used for smoke control in appropriate schedules. Include fans, drivers, variable frequency drives (VFDs) and their locations, and louver and damper operators. Indicate the minimum service factor for fan motors (1.15) and the minimum number of fan belts for belt-driven fans, and temperature rating of fans and ducts [CBC 909.10.5].
- 5.4.1.6. Identify the ducts and shafts used for smoke control in the schematic riser diagrams and plan drawings. Indicate the minimum test pressure for ducts and shafts used for smoke control (1.5 times the maximum design pressure) [CBC 909.10.2]. All shafts shall be sheet metal lined, unless an alternate method is approved [CMC 602].
- 5.4.1.7. For smoke control systems with variable frequency drives (VFDs), locate the VFDs outside the smoke zone they serve. Alternatively, protect VFDs within the smoke zone they serve from smoke and heat so they are capable of continued operation after detection of fire for at least 20 minutes or the time set by the required safe exiting time (1.5 times RSET), whichever is less [CBC 909.4.6.] VFDs shall not serve more than one end device unless listed for smoke control service.
- 5.4.1.8. For air-moving systems greater than 2,000 cfm, identify where automatic shutoffs are not provided due to smoke control [CMC 609 #4].

5.4.2. Prerequisites for a mechanical permit issuance: Approved architectural plans, approved Smoke Control Report, and an approved Special Inspection Program.

## 5.5. Electrical Permit Drawings

5.5.1. In addition to the information that is typically provided in electrical drawings, include the following information in the drawings:

5.5.1.1. Include a compliance statement stamped and wet signed by the electrical engineer-of-record which states:

“I have reviewed the Smoke Control Report and confirm the smoke management/control system shown in these drawings comply with the Smoke Control Report by *REPORT AUTHOR and DATE OF REPORT.*”

5.5.1.2. Identify the major electrical components used for smoke control, including standby (or emergency) power source, transfer switches, and control system(s).

5.5.1.3. Provide load calculations for the standby/emergency power source.

5.5.1.4. Show the layout of the standby generator room (or other secondary power source). The standby generator and its transfer switches shall be in a separate room from the normal power transformers and switchgear [CBC 909.11, 909.11.1].

5.5.1.5. Show the routing and fire rating of the normal and standby power distribution systems. The normal and standby power systems shall be routed independently [CBC 909.11].

5.5.1.6. Show the locations of the fire alarm control panel (FACP), firefighters' smoke control panel (FSCP) and fire alarm annunciator(s).

5.5.1.7. Provide a 1-line diagram showing feeder conductor sizes, overcurrent protection sizes, ampacity calculations, and the connected loads on each feeder supplied by the standby (or emergency) power source [CEC 215-5, 310, 700-5, 701-6].

5.5.1.8. For high-rise buildings, show the layout of the Fire Command Center (Central Control Station). See CBC 403.4.5, and 911, for required equipment and furnishings.

5.5.1.9. For buildings with passive smoke zones, connect the motor operators for smoke dampers to the building power panel and emergency/standby power – not the tenant space power panels.

## 5.6. Sprinkler System Permit Drawings

5.6.1. Sprinkler system submittals shall be in accordance with SFFD Administrative Bulletin AB 2.04, *Fire Sprinkler Submittals*.

5.6.2. In addition to the information that is typically provided in sprinkler system permit drawings, include the following information in the drawings:

5.6.2.1. The mechanical engineer-of-record shall review the sprinkler system permit documents for conformance with the smoke control report, prior to submittal to DBI/SFFD and shall so indicate by stamping “Reviewed for Smoke Control Design Compliance, *REPORT AUTHOR and DATE OF REPORT*” and signing on each drawing and document.

- 5.6.2.2. For atriums, provide separate sprinkler zones for the atrium and non-atrium spaces [CBC 909.12.3].
- 5.6.2.3. For malls, provide separate sprinkler zones for mall and tenant spaces [CBC 402.9, 909.12.3]
- 5.6.2.4. High-rise buildings with multiple active zones: each zone shall have 2 supplies.

## 5.7. Fire Alarm System Permit Drawings

- 5.7.1. Fire alarm submittals shall be in accordance with SFFD Administrative Bulletin AB 2.01, *Fire Alarm Submittals*.
- 5.7.2. In addition to the information that is typically provided in fire alarm system permit drawings, include the following information in the drawings:
  - 5.7.2.1. The mechanical engineer-of-record and electrical engineer-of-record shall review the sprinkler system permit documents for conformance with the smoke control report, prior to submittal to DBI/SFFD and each engineer shall so indicate by stamping "Reviewed for Smoke Control Design Compliance, *REPORT AUTHOR and DATE OF REPORT*" and signing on each drawing and document.
  - 5.7.2.2. Provide a detailed fire alarm/smoke control matrix.
    - 5.7.2.2.1. Show every fire alarm/smoke control system input in a column on the left. Include every initiating device by address. Inputs may be combined with prior approval. Include manual operation of control switches for fans and dampers where the switch controls multiple outputs.
    - 5.7.2.2.2. Show every fire alarm/smoke control system output in a row across the top. Include every notification appliance by zone, every fan and damper (or group of dampers) by identifier, every monitored device by identifier and every other event that must occur for proper operation of the smoke control system. Control may be combined with prior approval.
    - 5.7.2.2.3. Show automatic fan shutoffs per CMC 609 where required or provided.
    - 5.7.2.2.4. Show supervised conditions for required smoke control components such as fan power disconnect, pressure differentials switches, switches, fans not full speed, and doors/windows/dampers open or closed.
      - 5.7.2.2.5. Alarm, supervisory and trouble signals shall be transmitted to an approved supervising station in accordance with NFPA 72 [CBC 907.6.5].
  - 5.7.2.3. Provide a full scale color drawing of the Firefighters Smoke Control Panel (FSCP) for review and approval prior to fabrication [CBC 909.2.]
    - 5.7.2.3.1. Show individual control switches for fans and dampers or multiple dampers with identical actions, and automatic closing/opening doors required for smoke control [909.16.2.]
    - 5.7.2.3.2. The FSCP shall show status indicators for all smoke control equipment by pilot lamp-type indicators as follows[CBC 909.16.1]:

GREEN: Fans, dampers and other operating equipment are in their ON or OPEN status. Provide a green light to indicate Smoke Control Mode and another for Manual Mode.

RED: Fans, dampers and other operating equipment are in their OFF or CLOSED status.

YELLOW: Fans, dampers and other operating equipment are in a fault status.

Add two pilot lamp-type indicators at right top of FSCP to indicate panel is in smoke control mode: green-normal and red-smoke control mode.

5.7.2.3.3. Provide a legend or matrix either on the FSCP or separately mounted adjacent to the FSCP showing the configuration of fans, dampers and doors in normal status mode and smoke control status mode.

5.7.2.3.4. Alternate designs of the firefighters' smoke control panel may be approved on a case-by-case basis by SFFD.

5.7.2.4. Include a reference copy of the approved mechanical plans.

5.7.3. Smoke control systems shall have an automatic weekly self-test feature. The self-test feature shall automatically command activation of each associated function(s). An audible and visual trouble signal shall be annunciated at the FSCP identifying any function that fails to operate within the required time period [CBC 909.12, 907; UL 864].

## **5.8. Smoke Control Systems Designed Per the 1995, 1998, 2001, 2007 CBC/SFBC**

5.8.1. For existing smoke control systems designed per the 1995, 1998, 2001 or 2007 CBC/SFBC, comply with the requirements of Section 5 for the modified portions of the system except as revised in this section.

5.8.2. Where modifications to existing smoke control systems are made and original approved reports are not available, provide a new Smoke Control Report, Special Inspection Program and Final Testing Report.

5.8.3. Where modifications to existing smoke control systems are minor, DBI/SFFD may waive requirements for new reports or amendments to the original approved reports on a case-by-case basis. Minor modifications do not include new FSDs, smoke barriers/walls, a new Fire Alarm system, changes in use/occupancy, replacement of equipment (not in-kind), or like changes to the building and its systems.

5.8.4. Where work is done to a building with a smoke control system provide on plans a narrative of the smoke control/management system(s) operation and a matrix of fire/smoke damper operations for normal and smoke control modes of the smoke management system(s).

5.8.5. Where building renovations do not affect the design or operation of existing smoke control systems, provide the following non-infringement statement on the permit drawings:

"I have read the Smoke Control Report and confirm the building renovations in these drawings do not affect the design or operation of existing smoke control systems."

The non-infringement statement shall be signed by the architect and engineers-of-record (mechanical and electrical).

## **5.9. Smoke Control Systems Designed Per the 1992 CBC/SFBC or Earlier**

- 5.9.1. For smoke control systems designed per the 1992 CBC/SFBC or earlier, comply with the requirements of this section.
- 5.9.2. Where building renovations affect the design or operation of existing smoke control systems, provide a smoke control narrative on the permit drawings that describes the building renovations and modifications to the existing smoke control systems.
- 5.9.3. Where work is done to a building with a smoke control system provide on plans a narrative of the smoke control/management system(s) operation and a matrix of fire/smoke damper operations for normal and smoke control modes of the smoke management system(s).
- 5.9.4. Where building renovations do not affect the design or operation of existing smoke control systems, provide the following non-infringement statement on the permit drawings:

“The building renovations in these drawings do not affect the design or operation of existing smoke control systems.”

The non-infringement statement shall be signed by the architect and engineers-of-record.

## **6. SPECIAL INSPECTION REQUIREMENTS FOR SMOKE CONTROL SYSTEMS**

### **6.1. Special Inspector**

- 6.1.1. CBC, Section 909 requires a special inspector to perform inspection and acceptance testing of smoke control systems.
- 6.1.2. The special inspector is responsible for verifying that the smoke control system is installed in accordance with the requirements of CBC, Section 909, and that the system achieves the performance defined in the Smoke Control Report.

### **6.2. Inspection and Test Process**

- 6.2.1. Two inspection and testing processes are required for smoke control systems:
  - 6.2.1.1. Special inspection/testing by a special inspector, and
  - 6.2.1.2. When the special inspector is satisfied that the smoke control system is properly installed and functioning per design, DBI/SFFD inspectors witness final acceptance testing.

### **6.3. Submittals**

- 6.3.1. Two submittals are required to document special inspection:
  - 6.3.1.1. A written inspection and test program, and
  - 6.3.1.2. A report describing the inspection and testing performed (as required by CBC, Section 909.18.8, AB-046).

### **6.4. New and Modified Smoke Control Systems**



6.4.1. Inspection, testing and submittal requirements for projects involving modifications to existing smoke control systems are the same as for projects involving new smoke control systems. While new systems require 100 percent of the smoke control system to be tested, the extent of testing required for modifications to existing systems shall be approved by DBI/SFFD.

## **7. SPECIAL INSPECTION QUALIFICATIONS**

### **7.1. Special Inspector**

7.1.1. The special inspector shall be employed by the owner, owner's agent, architect or engineers-of-record but not the contractor or any other person responsible for the work [SFBC 106A.3.5].

7.1.2. The special inspector shall be a qualified person who shall demonstrate competence, to the satisfaction of DBI and SFFD, for the inspection and testing of smoke control systems.

7.1.3. The special inspector may be the smoke control system designer, if qualified per 7.1.2.

### **7.2. Testing Agencies**

7.2.1. Testing agencies shall be engaged by the owner or owner's agent; "The special inspector shall be employed by the owner, the engineer or architect of record, or an agent of the owner, but not the contractor or any other person responsible for the work" [SFBC 106A.3.5.]

7.2.2. Testing agencies that measure HVAC performance (TAB agencies) shall be certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB.)

## **8. SPECIAL INSPECTION SUBMITTALS FOR SMOKE CONTROL SYSTEMS**

### **8.1. Special Inspection Program**

#### **8.1.1. General**

8.1.1.1. A written Special Inspection Program shall be submitted to DBI/SFFD for review and approval [SFBC 106A.3.5].

8.1.1.2. The Special Inspection Program shall be prepared by the architect, mechanical engineer-of-record or the author of the Smoke Control Report. The Program may also be prepared by the special inspector if duly qualified. [CBC 909.18.8.2]

- Include the special inspector's resume with the special inspection program.

8.1.1.3. The Special Inspection Program shall be submitted with the complete Smoke Control Report for review with the Mechanical and Electrical drawings. The issuance of the mechanical and electrical permit is dependent on approval of the submittals of the Smoke Control Report and Special Inspection Program.

8.1.2. The Special Inspection Program shall include at least the following information:

8.1.2.1. Provide a cover page showing the facility name, address, revision number, date of submittal and preparer.

8.1.2.2. Provide a signature page per the attached form; AB-047 Attachment 1 signature page.

- 8.1.2.3. Identify the components and systems that must be inspected to demonstrate proper installation.
- 8.1.2.4. Samples of Inspection Reports and time limits for submission of reports.
- 8.1.2.5. Provide an overview of test methods and test approach.
  - 8.1.2.5.1. When leakage testing of residential smoke barriers is to be performed, the Special Inspection Program shall define the number or percentage of units (minimum of 10% of the units or 1 per floor, whichever is greater) to be tested. Include the method of testing, percentage of smoke barriers to be tested and pass/fail criteria.
  - 8.1.2.5.2. If cold/hot smoke visualization testing is required by SFFD, this must be specifically addressed in the Program description. Provide testing details and methods proposed.
- 8.1.3. Two hard-copies of the Program shall be submitted in booklet form to DBI for logging-in. One copy will be returned when approved. The Program documents shall be accompanied by two CD-Rs, each with a copy of the Program “burned” onto the CD-R in PDF format. Each CD-R shall be in a slim plastic “jewel case” with a clear cover. The permit application number, project name and address, report title, date and revision number shall be clearly marked on the CD-R.

## **8.2. Documentation to Support Final Inspection by DBI/SFFD**

- 8.2.1. When the special inspector determines that the smoke control system is complete and operating properly, then he/she shall write a letter documenting its status. The letter shall be provided to the DBI/SFFD inspectors.

The letter is required prior to DBI/SFFD starting their final inspection.

- 8.2.2. Satisfactory completion of final inspection of the smoke control system by DBI/SFD inspectors is a prerequisite for TCO.

## **8.3. Final Report for Special Inspection and Testing (Commissioning Report for CFO)**

- 8.3.1. A complete Smoke Control System Commissioning Report meeting the requirements of CBC 909.18.8.3 shall be submitted to DBI/SFFD for review and approval.
- 8.3.2. Acceptance of the Report by DBI/SFFD is a prerequisite for TOC.
- 8.3.3. Include completed attachments 2 and 3; Special Inspection and Testing Checklist, Final Report; for each smoke control system.
- 8.3.4. Two hard-copies of the Report shall be submitted to DBI in booklet format for logging-in. The Report copies shall be accompanied by two CD-Rs, each with a copy of the Report “burned” onto the CD-R in pdf format. Each CD-R shall be in a slim plastic “jewel case” with a clear cover. The permit application number, report title, project name and address, date and revision number shall be clearly marked on the CD-R.
- 8.3.5. A copy of the Report shall be provided to the SFFD inspector.
- 8.3.6. A copy of the Report shall be maintained in the fire control room.

## **9. INSPECTION AND TESTING OF SMOKE CONTROL SYSTEMS**

## 9.1. General

- 9.1.1. This section provides specific requirements and clarifications for the inspection and testing of new smoke control systems. These requirements are in addition to those specified in CBC, Section 909.
- 9.1.2. Projects involving modifications to existing smoke control systems shall employ only those requirements listed below applicable to the project.

## 9.2. SF Inspection and Testing Requirements

- 9.2.1. Special Inspector shall inspect and test to the following approved documents:
- 9.2.1.1. Smoke Control Report;
- 9.2.1.2. Fire Alarm system shop drawings with the detailed smoke control sequence of operations matrix and the approved Firefighter's Control Panel configuration;
- 9.2.1.3. Architectural plans, with emphasis on smoke barrier plans;
- 9.2.1.4. Fire Sprinkler plans, with focus on zoning and special design criteria required for smoke control design;
- 9.2.1.5. Mechanical plans;
- 9.2.1.6. And Electrical plans.
- 9.2.2. Witness duct and shaft leakage testing. The test method shall be in accordance with SMACNA, *HVAC Systems Testing, Adjusting and Balancing*, Second Edition, 1993. Leakage testing shall be performed prior to the installation of dampers, but with all laterals installed. The test pressure and allowable leakage shall be in accordance with CBC, 909.10.2.
- Testing shall be performed during erection of ductwork and prior to concealment.
- 9.2.3. Witness leakage testing of the number of dwelling units defined in the Special Inspection Program. Leakage testing shall be accomplished using a calibrated door-fan test rig. Test pressure shall be approximately 0.05 in. WG or greater as determined by design. Measured leakage shall be compared to compartment leakage determined by calculation using allowable barrier leakage area ratios in CBC, 909.5 or architectural specification as applicable.
- 9.2.4. Witness airflow testing.
- 9.2.5. Visually inspect representative portions of the installed perimeter fire-safing to verify installation per its Listing and/or engineering judgment.
- 9.2.6. Visually inspect the Firefighter's Control Panel (FFCP) and verify:
- 9.2.6.1. The configuration is consistent with approved fire alarm drawings;
- 9.2.6.2. The panel is representative of the building smoke control system;
- 9.2.6.3. Indicator lights meet San Francisco requirements:

- Green light: Fan ON or Damper OPEN;
- Red light: Fan OFF or Damper CLOSED;
- Yellow/Amber light: Damper/Fan FAULT or Loss of Power;

9.2.6.4. Verify that loss-of-power or airflow to each smoke control fan causes an immediate illumination of the associated FAULT light on the FSCP.

9.2.6.5. Verify that fire alarm control/monitor modules are within 3 feet of HVAC equipment used for smoke control OR that the wiring between is supervised.

9.2.6.6. Verify that the blades on each FSD are monitored. Grouped FSDs with independent motors and jackshafts require the blades of each FSD to be monitored.

9.2.6.7. Verify that all VFD control panels are removed or the HOA on each VFD is password-protected.

9.2.7. The condition of the building shall be as follows during testing:

9.2.7.1. Pressure testing shall be performed with:

9.2.7.1.1. Permanent power to the building and all smoke control equipment;

9.2.7.1.2. Windows and exterior doors CLOSED;

9.2.7.1.3. Sub-ducted exhaust systems (toilet, kitchen and dryer) ON at fire-event speeds;

9.2.7.1.4. Dampers and fans that shut down during a fire event are CLOSED/OFF.

9.2.7.2. Proper operation of the smoke control system under standby power shall be verified (as a minimum) by:

- Verifying that current and voltage under normal and standby power are equivalent

9.2.7.3. Current switches shall be adjusted after the building has been verified to be properly balanced. Adjustment shall be verified to indicate a no-belt condition, where appropriate.

9.2.8. The weekly self-test shall be observed and the following verified:

9.2.8.1. A written report is produced. The report must clearly indicate a “start” of the test and an “end.” The report must clearly indicate any failures, but need not specify the component that fails.

9.2.8.2. The test shall cycle those components required for proper operation of the smoke control system as identified in the smoke control report.

9.2.8.3. Any failure during the self-test shall place a “TROUBLE” on the fire alarm control panel and notify Central Station.

9.2.8.4. Any alarm shall interrupt the self-test.

9.2.9. Special Inspector shall verify that documentation and equipment labels are in order.

- 9.2.9.1. Verify that all fans and dampers used for smoke control are field labeled consistent with the control drawings (approved fire alarm drawings) and the Firefighter's Control Panel (FFCP). Fan labels shall be red phenolic with 1" white lettering. Where the fan and the local disconnect/control panel are not immediately adjacent, both shall be labeled.
- 9.2.9.2. Verify that the following are available (or will be available) in the fire control room:
  - 9.2.9.2.1. As-built fire alarm (control) shop drawings;
  - 9.2.9.2.2. Smoke control event matrix (typically in the approved fire alarm shop drawings);
  - 9.2.9.2.3. The approved smoke control report;
  - 9.2.9.2.4. Weekly self-test reports;
  - 9.2.9.2.5. Final Smoke Control Special Inspection report.

### AB-047 Attachment 1

### Signature Page

Check applicable box and provide signatures as noted:

- Preliminary Smoke Control Report—Owner and Preparer
- Final Smoke Control Report—all sign
- Special Inspection Program— Owner and Preparer

Project:

Prepared by:

_____	_____	_____	_____
Preparer	License #	Company	Date

Reviewed and approved by:

_____	_____	_____	_____
Owner's Representative	License #	Company	Date

Reviewed and approved by:

I have reviewed this report and confirm, to the best of my knowledge, the smoke control system design is in compliance with this report and applicable codes and standards.

_____	_____	_____	_____
Architect-of-Record	License #	Company	Date

_____	_____	_____	_____
Mechanical Engineer-of-Record	License #	Company	Date

_____	_____	_____	_____
Electrical Engineer-of-Record	License #	Company	Date

Instructions: A signature page similar to the format shown shall be included in each submittal of the Smoke Control Report and Special Inspection Program.

## AB-047 Attachment 2

### Special Inspection and Testing Summary Checklist

Project:

Special Inspector:

<b>1. Inspect Installed System for Compliance with Design</b>	<b>Yes</b>	<b>No</b>
a. Substantially complies with CBC 909	<input type="checkbox"/>	<input type="checkbox"/>
b. Substantially complies with approved Smoke Control Report	<input type="checkbox"/>	<input type="checkbox"/>
c. Substantially complies with approved drawings	<input type="checkbox"/>	<input type="checkbox"/>
<b>2. Inspect Installed Components for Compliance with Code Requirements</b>		
a. Fans [909.10.5]	<input type="checkbox"/>	<input type="checkbox"/>
b. Ducts and dampers [909.10.2,909.10.4, 716]	<input type="checkbox"/>	<input type="checkbox"/>
c. Power [909.11, 909.11.1]	<input type="checkbox"/>	<input type="checkbox"/>
d. Detection and control [909.12, 909.12.1, 909.12.2]	<input type="checkbox"/>	<input type="checkbox"/>
e. Control air tubing [909.13, 909.13.1, 909.13.2, 909.13.3]	<input type="checkbox"/>	<input type="checkbox"/>
f. Marking and identification [909.14]	<input type="checkbox"/>	<input type="checkbox"/>
g. Control diagrams [909.15]	<input type="checkbox"/>	<input type="checkbox"/>
<b>3. Test Components and System for Compliance with Code Requirements</b>		
a. Smoke barriers – pressure differential tests comply [909.5.1, 909.18.6]	<input type="checkbox"/>	<input type="checkbox"/>
b. Fans – motor running tests comply [909.10.5]	<input type="checkbox"/>	<input type="checkbox"/>
c. Ducts – pressure and flow tests comply [909.10.2, 909.18.2]	<input type="checkbox"/>	<input type="checkbox"/>
d. Dampers – proper operation [909.18.3]	<input type="checkbox"/>	<input type="checkbox"/>
e. Power transfer within 60 seconds [909.11]	<input type="checkbox"/>	<input type="checkbox"/>
f. Control air tubing – pressure tests comply [909.13.3]	<input type="checkbox"/>	<input type="checkbox"/>
g. Detection devices – proper operation [909.18.1]	<input type="checkbox"/>	<input type="checkbox"/>
h. Firefighters' smoke control panel – proper operation [909.18.7]	<input type="checkbox"/>	<input type="checkbox"/>
i. Component response times comply [909.17]	<input type="checkbox"/>	<input type="checkbox"/>
j. Smoke control system – proper operation for each zone [909.18.7]	<input type="checkbox"/>	<input type="checkbox"/>

Instructions: Complete this form and include in the Final Commissioning Report. The Final Commissioning Report may be rejected for "No" answers without acceptable explanations.

### **AB-047 Attachment 3 Special Inspection and Final Report**

**Special Inspection Final Report—Engineers of Record sign**

Project:

A complete report of testing shall be prepared by the required special inspector or special inspection agency. The report shall include identification of all devices by manufacturer, nameplate data, design values, measured values, and identification tag or mark. The report shall be reviewed by the responsible registered design professionals, and when satisfied that the design intent has been achieved, the responsible registered design professionals shall seal, sign and date to the report with a statement as follows:

I have reviewed this report and by personal knowledge and on-site observation certify that the smoke control system is in substantial compliance with the design intent, and to the best of my understanding complies with requirements if the code.

Architect-of-Record	License #	Company	Date
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Mechanical Engineer-of-Record	License #	Company	Date
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Electrical Engineer-of-Record	License #	Company	Date
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